STIC Search Report
EIC 1700

Scientific & Technical Information Center
USPTO

STIC Database Tracking Number: 162535

TO:	From:
Mahomoud Dahimene **Location: REM 9A70** **Art Unit : 1765** **September 9, 2005** **Case Serial Number: 10/730234**	**Kathleen Fuller** **Location: EIC 1700** **REMSEN 4B28** **Phone: 571/272-2505** **Kathleen.Fuller@uspto.gov**

Search Notes

I only found found the applicant with both the pull back and second mask concept. I searched many files including the EP full text patent file.

pg Pub 20040266076

sira
Search and Information Resources Administration

Smith, Teresa (ASRC)

From: Unknown@Unknown.com
Sent: Monday, August 15, 2005 10:29 AM
To: STIC-EIC1700
Subject: Generic form response

ResponseHeader=Commercial Database Search Request

AccessDB#= 162535

LogNumber= _____

Searcher= _____

SearcherPhone= _____

SearcherBranch= _____

MyDate=Mon Aug 15 10:29:01 EDT 2005

submitto=STIC-EIC1700@uspto.gov

Name=Mahmoud Dahimene

Empno=81440

Phone=22410

Artunit=1765

Office=REM 9A70

Serialnum=10730234

PatClass=216/011.000

Earliest=12/09/2003

Format3=email

Searchtopic=The application I am examining relates to a method of forming Fins for "FinFET" transistors. The method uses a hard mask pull-back method to get around the photolithography limitations for features smaller than 50 nanometers. The two key features the applicant uses are "hard mask pull-back" and "second hard mask". I could find references for each feature separately. I need a reference that combines both features, or both features separately related to the formation of "FinFET" transistor fabrication. The mask "pull-back" method is well know, by itself, for trench corner rounding, or adjustments of masks in lithography. However, no reference combines mask pull-back and deposition and etch of a second hard mask to allow the fabrication of features substantially smaller than the present lithography limits would allow.

The key-words/expressions are: FinFET ; Fins ; hard mask pull-back (or mask pull-back) ; second hard mask ; Etching ; 50 nanometers and smaller features ; silicon ; oxide.

Comments=If you have questions please call 22410.
I am usually at my desk between 7:30 AM. and 4:00 PM

send=SEND

STIC Search Results Feedback Form

USPTO

EIC17000

Questions about the scope or the results of the search? Contact *the EIC searcher or contact:*

Kathleen Fuller, EIC 1700 Team Leader
571/272-2505 REMSEN 4B28

Voluntary Results Feedback Form

- *I am an examiner in Workgroup:* ☐ *Example: 1713*
- *Relevant prior art **found**, search results used as follows:*
  - ☐ 102 rejection
  - ☐ 103 rejection
  - ☐ Cited as being of interest.
  - ☐ Helped examiner better understand the invention.
  - ☐ Helped examiner better understand the state of the art in their technology.

Types of relevant prior art found:

- ☐ Foreign Patent(s)
- ☐ Non-Patent Literature
  (journal articles, conference proceedings, new product announcements etc.)

- *Relevant prior art **not found:***
  - ☐ Results verified the lack of relevant prior art (helped determine patentability).
  - ☐ Results were not useful in determining patentability or understanding the invention.

Comments:

```
=> FILE HCAPL
FILE 'HCAPLUS' ENTERED AT 16:51:30 ON 09 SEP 2005
USE IS SUBJECT TO THE TERMS OF YOUR STN CUSTOMER AGREEMENT.
PLEASE SEE "HELP USAGETERMS" FOR DETAILS.
COPYRIGHT (C) 2005 AMERICAN CHEMICAL SOCIETY (ACS)
```



```
FILE COVERS 1907 - 9 Sep 2005  VOL 143 ISS 12
FILE LAST UPDATED: 8 Sep 2005  (20050908/ED)

New CAS Information Use Policies, enter HELP USAGETERMS for details.

 This file contains CAS Registry Numbers for easy and accurate
 substance identification.

=> D QUE L15
L3        433057 SEA FILE=HCAPLUS ABB=ON  FIN#
L4            17 SEA FILE=HCAPLUS ABB=ON  L3 AND (PULL?(W)BACK? OR PULLBACK?)
L7             1 SEA FILE=HCAPLUS ABB=ON  L4 AND (2ND OR SECOND OR TWO)(3A)(MASK
                 ? OR HARDMASK?)
L8             1 SEA FILE=HCAPLUS ABB=ON  FINFET? AND (PULL?(W)BACK? OR
                 PULLBACK?)
L9             1 SEA FILE=HCAPLUS ABB=ON  L8 AND (2ND OR SECOND OR TWO)(3A)(MASK
                 ? OR HARDMASK?)
L10            1 SEA FILE=HCAPLUS ABB=ON  L7 OR L9
L14            1 SEA FILE=HCAPLUS ABB=ON  (L4 OR L8) AND (MANY OR MULTI? OR
                 FIRST OR 1ST)(3A)(MASK? OR HARDMASK?)
L15            1 SEA FILE=HCAPLUS ABB=ON  L14 OR L10

=> D L15 ALL

L15  ANSWER 1 OF 1  HCAPLUS  COPYRIGHT 2005 ACS on STN
AN   2005:493262  HCAPLUS
DN   143:17787
ED   Entered STN:  10 Jun 2005
TI   Pull-back method of forming fins in
     FinFETs
IN   Beintner, Jochen C.; Chidambarrao, Dureseti; Li, Yujun; Settlemyer,
     Kenneth T.
PA   International Business Machines Corporation, USA
SO   U.S. Pat. Appl. Publ., 15 pp.
     CODEN: USXXCO
DT   Patent
LA   English
IC   ICM  B44C001-22
     ICS  C25F003-00
INCL 216011000
CC   76-2 (Electric Phenomena)
     Section cross-reference(s): 72, 78
```

applicant

FAN.CNT 1

	PATENT NO.	KIND	DATE	APPLICATION NO.	DATE
PI	US 2005121412	A1	20050609	US 2003-730234	20031209
	JP 2005175480	A2	20050630	JP 2004-353535	20041207
PRAI	US 2003-730234	A	20031209		

CLASS

PATENT NO.	CLASS	PATENT FAMILY CLASSIFICATION CODES
US 2005121412	ICM	B44C001-22
	ICS	C25F003-00
	INCL	216011000
US 2005121412	NCL	216/011.000
JP 2005175480	FTERM	5F110/AA07; 5F110/AA30; 5F110/DD05; 5F110/DD13; 5F110/EE01; 5F110/EE08; 5F110/EE22; 5F110/EE27; 5F110/GG02; 5F110/GG12; 5F110/GG22; 5F110/QQ11; 5F110/QQ19; 5F140/AA00; 5F140/AA29; 5F140/AA39; 5F140/AC36; 5F140/BB03; 5F140/BC15; 5F140/BF01; 5F140/BF04; 5F140/BF10; 5F140/BF44

AB A method of forming integrated circuits having **FinFET** transistors includes a method of forming sub-lithog. **fins**, in which a mask defining a block of silicon including a pair of **fins** in reduced in width or **pulled back** by the thickness of one **fin** on each side, after which a **second mask** is formed around the **first mask**, so that after the **first mask** is removed, an aperture remains in the **second mask** having the width of the separation distance between the pair of **fins.** When the silicon is etched through the aperture, the **fins** are protected by the **second mask**, thereby defining **fin** thickness by the **pullback** step. An alternative method uses lithog. of opposite polarity, first defining the central etch aperture between the two **fins** lithog., then expanding the width of the aperture by a **pullback** step, so that filling the widened aperture with an etch-resistant plug defines the outer edges of the pair of **fins**, thereby setting the **fin** width without an alignment kstep.

ST field effect transistor **fins** silicon masking etching

IT Coating materials
(masking; **pull-back** method of forming **fins** in **finFET** using)

IT Field effect transistors
Lithography
(**pull-back** method of forming **fins** in **finFET**)

IT Etching
(**pull-back** method of forming **fins** in **finFET** using)

IT Integrated circuits
(**pull-back** method of forming **fins** in **finFETs**)

IT 7440-21-3, Silicon, processes
RL: CPS (Chemical process); DEV (Device component use); PEP (Physical, engineering or chemical process); RCT (Reactant); PROC (Process); RACT (Reactant or reagent); USES (Uses)
(**pull-back** method of forming **fins** in **finFET** using)

IT 12033-89-5P, Silicon Nitride, processes
RL: CPS (Chemical process); PEP (Physical, engineering or chemical process); PNU (Preparation, unclassified); PREP (Preparation); PROC (Process)

(**pull-back** method of forming **fins** in **finFET** using mask from)
IT 7631-86-9P, Silica, processes
RL: CPS (Chemical process); PEP (Physical, engineering or chemical process); PNU (Preparation, unclassified); RCT (Reactant); PREP (Preparation); PROC (Process); RACT (Reactant or reagent)
(**pull-back** method of forming **fins** in **finFET** using mask from nitride on)

=> FILE WPIX
FILE 'WPIX' ENTERED AT 16:52:00 ON 09 SEP 2005
COPYRIGHT (C) 2005 THE THOMSON CORPORATION

FILE LAST UPDATED: 7 SEP 2005 <20050907/UP>
MOST RECENT DERWENT UPDATE: 200557 <200557/DW>
DERWENT WORLD PATENTS INDEX SUBSCRIBER FILE, COVERS 1963 TO DATE

>>> FOR A COPY OF THE DERWENT WORLD PATENTS INDEX STN USER GUIDE, PLEASE VISIT:
http://www.stn-international.de/training_center/patents/stn_guide.pdf <<<

>>> FOR DETAILS OF THE PATENTS COVERED IN CURRENT UPDATES, SEE http://thomsonderwent.com/coverage/latestupdates/ <<<

>>> FOR INFORMATION ON ALL DERWENT WORLD PATENTS INDEX USER GUIDES, PLEASE VISIT:
http://thomsonderwent.com/support/userguides/ <<<

>>> NEW! FAST-ALERTING ACCESS TO NEWLY-PUBLISHED PATENT DOCUMENTATION NOW AVAILABLE IN DERWENT WORLD PATENTS INDEX FIRST VIEW - FILE WPIFV.
FOR FURTHER DETAILS: http://www.thomsonderwent.com/dwpifv <<<

>>> THE CPI AND EPI MANUAL CODES HAVE BEEN REVISED FROM UPDATE 200501.
PLEASE CHECK:
http://thomsonderwent.com/support/dwpiref/reftools/classification/code-revision/
FOR DETAILS. <<<

=>

=> D QUE L13
L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)
L7 1 SEA FILE=HCAPLUS ABB=ON L4 AND (2ND OR SECOND OR TWO)(3A)(MASK ? OR HARDMASK?)
L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR PULLBACK?)
L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO)(3A)(MASK ? OR HARDMASK?)
L11 1 SEA FILE=WPIX ABB=ON L7 OR L9
L12 1 SEA FILE=WPIX ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR FIRST OR 1ST)(3A)(MASK? OR HARDMASK?)
L13 1 SEA FILE=WPIX ABB=ON L11 OR L12

=> D FULL L13

L13 ANSWER 1 OF 1 WPIX COPYRIGHT 2005 THE THOMSON CORP on STN
AN 2005-455797 [46] WPIX

DNN N2005-370399 DNC C2005-138706
TI Formation of **fins** extending from substrate for FET comprises reducing transverse dimensions of **first hardmask** above **fin** block and removing **first hardmask** leaving etch aperture in **second hardmask** having width equal to **fin** separation distance.
DC L03 P78 U11 U12
IN BEINTNER, J C; CHIDAMBARRAO, D; LI, Y; SETTLEMYER, K T
PA (IBMC) IBM CORP; (IBMC) INT BUSINESS MACHINES CORP
CYC 2
PI US 2005121412 A1 20050609 (200546)* 15 B44C001-22
JP 2005175480 A 20050630 (200546) 17 H01L029-786
ADT US 2005121412 A1 US 2003-730234 20031209; JP 2005175480 A JP 2004-353535 20041207
PRAI US 2003-730234 20031209
IC ICM B44C001-22; H01L029-786
ICS C25F003-00; H01L021-336; H01L029-78
AB US2005121412 A UPAB: 20050720
NOVELTY - Forming **fin**(s) extending from a substrate comprises depositing **first hardmask** on **fin** layer; patterning **fin** layer to form **fin** block(s); reducing the transverse dimensions of **first hardmask** above **fin** block(s) by an amount greater than or equal to the thickness of two **fins**; forming a **second hardmask**; and removing **first hardmask**, leaving etch aperture(s) in **second hardmask** having a width equal to a **fin** separation distance.

DETAILED DESCRIPTION - Forming **fin**(s) extending from a substrate comprises providing a **fin** layer (50) of semiconductor on the substrate (10); depositing a **first hardmask** on the **fin** layer; patterning the **fin** layer to form **fin** block(s); reducing the transverse dimensions of the **first hardmask** above the **fin** block(s) by an amount greater than or equal to the thickness of two **fins**; forming a **second hardmask** about and adjacent to the **first hardmask**; removing the **first hardmask**, leaving etch aperture(s) in the **second hardmask** having a width equal to a **fin** separation distance between adjacent **fins**; and etching the **fin** layer through the aperture(s) to form the **fin**(s).

USE - For forming **fin**(s) extending from a substrate for forming integrated circuits having double gate field effect transistors (**FinFET**).

ADVANTAGE - The vertical silicon slices that contain the transistor body (**fins**) are defined in a self-aligned fashion relative to a block of silicon so that the **fin** width does not depend on tolerances in alignment but on a material removal process.

DESCRIPTION OF DRAWING(S) - The figure shows silicon blocks after a **pull-back** operation that reduces the width of the hardmask.

Substrate 10
Buried oxide insulator layer 20
Fin layer 50
Layer of oxide 52
Thinner dimension 53
Layer of nitride 54

Dwg.2/12
TECH US 2005121412 A1UPTX: 20050720
TECHNOLOGY FOCUS - CERAMICS AND GLASS - Preferred Materials: The **first hardmask** comprises a layer of nitride (54) above a

layer of oxide (52). The **fin** layer comprises silicon.

TECHNOLOGY FOCUS - MECHANICAL ENGINEERING - Preferred Method: The step of reducing comprises etching vertical sides of the **first hardmask** with a wet etch. An aperture extending over one side of a **fin** block of a set of **fin** blocks is lithographically defined after forming the **second hardmask** and before removing the **first hardmask.** A blocking **mask** is lithographically defined over an end portion of the set of **fin** blocks to prevent the end portion of the set of **fin** blocks from being separated.

TECHNOLOGY FOCUS - ORGANIC CHEMISTRY - Preferred Materials: The wet etch is a mixture of hydrogen fluoride (HF) and ethylene glycol (EG).

FS CPI EPI GMPI
FA AB; GI
MC CPI: L04-C06A; L04-E01A
EPI: U11-C05E3; U11-C05F1; U12-D02A9; U12-E02

=> FILE INSPEC
FILE 'INSPEC' ENTERED AT 16:52:39 ON 09 SEP 2005
Compiled and produced by the IEE in association with FIZ KARLSRUHE
COPYRIGHT 2005 (c) INSTITUTION OF ELECTRICAL ENGINEERS (IEE)

FILE LAST UPDATED: 5 SEP 2005 <20050905/UP>
FILE COVERS 1969 TO DATE.

<<< SIMULTANEOUS LEFT AND RIGHT TRUNCATION AVAILABLE IN THE BASIC INDEX >>>

=> D QUE L16
L3 433057 SEA FILE=HCAPLUS ABB=ON FIN#
L4 17 SEA FILE=HCAPLUS ABB=ON L3 AND (PULL?(W)BACK? OR PULLBACK?)
L7 1 SEA FILE=HCAPLUS ABB=ON L4 AND (2ND OR SECOND OR TWO)(3A)(MASK ? OR HARDMASK?)
L8 1 SEA FILE=HCAPLUS ABB=ON FINFET? AND (PULL?(W)BACK? OR PULLBACK?)
L9 1 SEA FILE=HCAPLUS ABB=ON L8 AND (2ND OR SECOND OR TWO)(3A)(MASK ? OR HARDMASK?)
L10 1 SEA FILE=HCAPLUS ABB=ON L7 OR L9
L14 1 SEA FILE=HCAPLUS ABB=ON (L4 OR L8) AND (MANY OR MULTI? OR FIRST OR 1ST)(3A)(MASK? OR HARDMASK?)
L16 0 SEA FILE=INSPEC ABB=ON L14 OR L10

=> FILE COMPENDEX
FILE 'COMPENDEX' ENTERED AT 16:52:59 ON 09 SEP 2005
Compendex Compilation and Indexing (C) 2005
Elsevier Engineering Information Inc (EEI). All rights reserved.
Compendex (R) is a registered Trademark of Elsevier Engineering Information Inc.

FILE LAST UPDATED: 5 SEP 2005 <20050905/UP>
FILE COVERS 1970 TO DATE.

<<< SIMULTANEOUS LEFT AND RIGHT TRUNCATION AVAILABLE IN THE BASIC INDEX >>>

<<< SOME LITTLE CHANGES IN TEXT OF CLASSIFICATION AS OF JUNE 13, 2005 SEE HELP CLA >>>

```
=> D QUE L17
L3        433057 SEA FILE=HCAPLUS ABB=ON  FIN#
L4            17 SEA FILE=HCAPLUS ABB=ON  L3 AND (PULL?(W)BACK? OR PULLBACK?)
L7             1 SEA FILE=HCAPLUS ABB=ON  L4 AND (2ND OR SECOND OR TWO)(3A)(MASK
                 ? OR HARDMASK?)
L8             1 SEA FILE=HCAPLUS ABB=ON  FINFET? AND (PULL?(W)BACK? OR
                 PULLBACK?)
L9             1 SEA FILE=HCAPLUS ABB=ON  L8 AND (2ND OR SECOND OR TWO)(3A)(MASK
                 ? OR HARDMASK?)
L10            1 SEA FILE=HCAPLUS ABB=ON  L7 OR L9
L14            1 SEA FILE=HCAPLUS ABB=ON  (L4 OR L8) AND (MANY OR MULTI? OR
                 FIRST OR 1ST)(3A)(MASK? OR HARDMASK?)
L17            0 SEA FILE=COMPENDEX ABB=ON  L14 OR L10


=> FILE NTIS
FILE 'NTIS' ENTERED AT 16:53:11 ON 09 SEP 2005
Compiled and distributed by the NTIS, U.S. Department of Commerce.
It contains copyrighted material.
All rights reserved. (2005)

FILE LAST UPDATED: 5 SEP 2005       <20050905/UP>
FILE COVERS 1964 TO DATE.

<<< SIMULTANEOUS LEFT AND RIGHT TRUNCATION AVAILABLE IN
    THE BASIC INDEX (/BI) >>>

=> D QUE L18
L3        433057 SEA FILE=HCAPLUS ABB=ON  FIN#
L4            17 SEA FILE=HCAPLUS ABB=ON  L3 AND (PULL?(W)BACK? OR PULLBACK?)
L7             1 SEA FILE=HCAPLUS ABB=ON  L4 AND (2ND OR SECOND OR TWO)(3A)(MASK
                 ? OR HARDMASK?)
L8             1 SEA FILE=HCAPLUS ABB=ON  FINFET? AND (PULL?(W)BACK? OR
                 PULLBACK?)
L9             1 SEA FILE=HCAPLUS ABB=ON  L8 AND (2ND OR SECOND OR TWO)(3A)(MASK
                 ? OR HARDMASK?)
L10            1 SEA FILE=HCAPLUS ABB=ON  L7 OR L9
L14            1 SEA FILE=HCAPLUS ABB=ON  (L4 OR L8) AND (MANY OR MULTI? OR
                 FIRST OR 1ST)(3A)(MASK? OR HARDMASK?)
L18            0 SEA FILE=NTIS ABB=ON  L14 OR L10


=> FILE JICST
FILE 'JICST-EPLUS' ENTERED AT 16:53:26 ON 09 SEP 2005
COPYRIGHT (C) 2005 Japan Science and Technology Agency (JST)

FILE COVERS 1985 TO 7 SEP 2005 (20050907/ED)

THE JICST-EPLUS FILE HAS BEEN RELOADED TO REFLECT THE 1999 CONTROLLED
TERM (/CT) THESAURUS RELOAD.

=> D QUE L19
L3        433057 SEA FILE=HCAPLUS ABB=ON  FIN#
L4            17 SEA FILE=HCAPLUS ABB=ON  L3 AND (PULL?(W)BACK? OR PULLBACK?)
L7             1 SEA FILE=HCAPLUS ABB=ON  L4 AND (2ND OR SECOND OR TWO)(3A)(MASK
                 ? OR HARDMASK?)
L8             1 SEA FILE=HCAPLUS ABB=ON  FINFET? AND (PULL?(W)BACK? OR
                 PULLBACK?)
L9             1 SEA FILE=HCAPLUS ABB=ON  L8 AND (2ND OR SECOND OR TWO)(3A)(MASK
```

```
                ? OR HARDMASK?)
L10           1 SEA FILE=HCAPLUS ABB=ON  L7 OR L9
L14           1 SEA FILE=HCAPLUS ABB=ON  (L4 OR L8) AND (MANY OR MULTI? OR
                FIRST OR 1ST)(3A)(MASK? OR HARDMASK?)
L19           0 SEA FILE=JICST-EPLUS ABB=ON  L14 OR L10


=> FILE JAPIO
FILE 'JAPIO' ENTERED AT 16:53:45 ON 09 SEP 2005
COPYRIGHT (C) 2005 Japanese Patent Office (JPO)- JAPIO

FILE LAST UPDATED: 5 SEP 2005       <20050905/UP>
FILE COVERS APR 1973 TO APRIL 28, 2005

<<< GRAPHIC IMAGES AVAILABLE >>>

=> D QUE L20
L3       433057 SEA FILE=HCAPLUS ABB=ON  FIN#
L4           17 SEA FILE=HCAPLUS ABB=ON  L3 AND (PULL?(W)BACK? OR PULLBACK?)
L7            1 SEA FILE=HCAPLUS ABB=ON  L4 AND (2ND OR SECOND OR TWO)(3A)(MASK
                ? OR HARDMASK?)
L8            1 SEA FILE=HCAPLUS ABB=ON  FINFET? AND (PULL?(W)BACK? OR
                PULLBACK?)
L9            1 SEA FILE=HCAPLUS ABB=ON  L8 AND (2ND OR SECOND OR TWO)(3A)(MASK
                ? OR HARDMASK?)
L10           1 SEA FILE=HCAPLUS ABB=ON  L7 OR L9
L14           1 SEA FILE=HCAPLUS ABB=ON  (L4 OR L8) AND (MANY OR MULTI? OR
                FIRST OR 1ST)(3A)(MASK? OR HARDMASK?)
L20           0 SEA FILE=JAPIO ABB=ON  L14 OR L10


=> FILE EPFUL
FILE 'EPFULL' ENTERED AT 16:53:57 ON 09 SEP 2005
COPYRIGHT (C) 2005 European Patent Office / FIZ Karlsruhe

FILE LAST UPDATED:      7 SEP 2005         <20050907/UP>
FILE COVERS 1978 TO DATE

>>> SIMULTANEOUS LEFT AND RIGHT TRUNCATION IS AVAILABLE
    IN FIELDS /BI and /CLM.  <<<

>>> For changes in EPFULL compared to EUROPATFULL please see
    => HELP CHANGE  (last updated January 11, 2005). <<<

>>> File enhanced with backlog data
    At June 06, 20, 21, 24, and 27, and July 18, 2005 bibliographies
    for A-documents between 1978 and 1997 have been added to the
    EPFULL file.  Please consider this in your search strategy.
    See HELP CURRENT for details. <<<

=> D QUE L26
L22          94 SEA FILE=EPFULL ABB=ON  (FINS OR FIN OR FINFET?)(P)(PULL?(W)BAC
                K? OR PULLBACK?)
L24           0 SEA FILE=EPFULL ABB=ON  L22(P)(2ND OR SECOND OR TWO)(3A)(MASK?
                OR HARDMASK?)
L25           0 SEA FILE=EPFULL ABB=ON  L22(P)(MANY OR MULTI? OR FIRST OR
                1ST)(3A)(MASK? OR HARDMASK?)
L26           0 SEA FILE=EPFULL ABB=ON  L24 OR L25
```